prising that at the outset Koch spoke of the swarms of rods, straight or slightly curved, which he found in the intestines of cholera patients as bacilli; and, indeed, the fact that these rods were capable of developing into spiral filaments could only be determined by protracted observations and by making pure cultures. It seems to me that some of Koch's critics, and especially Ray Lankester (see his paper in *Nature*, Dec. 25, 1884), are making altogether too much of this very pardonable mistake, which has no special bearing upon

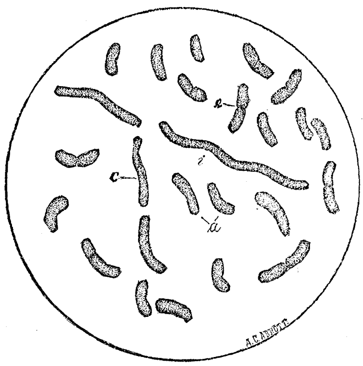

Fig. 1.—Comma bacillus (Koch) × 2,500 diameters.

the real question at issue, and cannot weaken our confidence in the candor and scientific accuracy of a man to whom we are so deeply indebted, and whose scientific reputation is established upon a firm foundation.

Ray Lankester is unquestionably right when he says that our knowledge of the bacteria is still in its infancy; but, so far as this knowledge goes, it is doubtful whether any man living can speak with more authority than can the discoverer of the tubercle bacillus.

The amplification in the figures illustrating this paper is exactly twenty-five hundred diameters, and was obtained with admirable definition by the use of Zeiss's one-eighteenth inch homogeneous immersion objective upon a Powell and Lealand's large stand, with a high eye-piece, and the draw-tube extended one inch. The measurement was made by projecting the lines from a standard stage-micrometer, ruled by Professor Rogers of Cambridge, Mass., upon a sheet of paper in the exact position in which the drawing was made, by means of the same objective, eye-piece, and camera lucida. Fig. 2 was made in the same way, and represents curved bacilli, which resemble the 'comma bacillus,' and which are, perhaps, identical with those described by Prof. T. R. Lewis as found in the healthy human mouth. The specimen from which the drawing was made was one of sputum from a patient with pneumonia. I think it hardly necessary to insist that the bacilli in fig. 2 are not morphologically identical with the 'comma bacillus' of Koch as shown in fig. 1; and I may say here, that, during my somewhat extended bacteriological studies, I have never encountered an organism which seems to me to be identical with that seen in the slide above referred to. Should such an organism be found, it would not in the least weaken the experimental evidence relating to

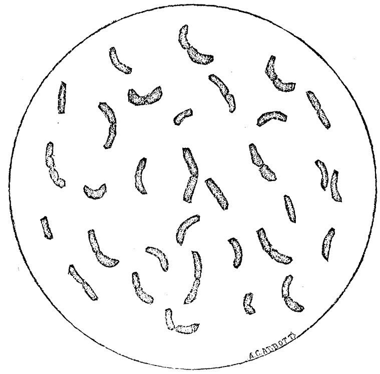

Fig. 2.—Bacilli found in pneumonic sputum × 2,500 diameters.

the specific pathogenic power claimed for this spirillum. But we must insist, in any case, that this experimental evidence shall meet the most rigid exactions of science. Certainly, Koch fully appreciates this, and is doing his utmost to comply with the conditions which he has imposed upon himself. We are therefore not able to sympathize with the captious spirit of some of his critics. Nor, in the absence of a detailed report, are we prepared to admit that the English cholera commission has definitely settled the question as to the etiological *rôle* of the 'comma bacillus' during the comparatively brief time which has been devoted to the investigation; and, in view of the contradictory testimony now before us, we cannot do otherwise than consider the question still *sub judice*, and wait patiently for detailed reports and additional experimental evidence.

George M. Sternberg,
Surgeon U. S. army.

LIGHTHOUSE ILLUMINANTS.

A parliamentary document is not the place where one would naturally look for facts of scientific value: but, in a return published by the English house of commons on the 11th of December last, there is

much interesting information on the subject of lighthouse illuminants in the form of correspondence between the Board of trade, which has general supervision of the lights of Great Britain; the Trinity house, which manages the English lights; and the Commissioners of northern lights, who have control over those of Scotland.

It may be remembered that in 1883 it was proposed to make exhaustive tests of the relative value of petroleum, gas, and electricity, as illuminants for lighthouses, by comparing the several lights in actual operation together at the South Foreland station; and the lighthouse authorities of all three kingdoms had arranged to act conjointly in prosecuting the experiments. When, however, the conditions under which the trials were to take place were formulated, the representatives from Ireland considered that these would place the system favored by the Irish authorities — the Wigham gas system — at a disadvantage, and refused to take further part in the proceedings.

Dr. Tyndall, who had for years acted as scientific adviser to the Trinity house, but had prior to this resigned, then wrote certain letters to the newspapers on the subject. These letters appear, says the Board of trade, to assert the superiority of gas, as used in Mr. Wigham's burners, as a lighthouse illuminant; and, further, to imply that the engineer of the board, Mr. (now Sir James) Douglass, has not been entirely disinterested. The Board of trade therefore asked for a full report of the views of the English and Scotch lighthouse boards on the whole question; and their replies, which give a fair idea of the present state of development of illuminants adapted to this special purpose, may be taken to be the defence of the board against Dr. Tyndall's strictures.

From the learned professor's statement, it appears that in 1869, when he was sent to Ireland to make himself acquainted with the gas system of lighthouse illumination, colza-oil was used in the Trinity-house lamps; and this was superseded, at a vast saving to the country, by mineral oil. Mr. Wigham had succeeded in producing a gas-lamp superior in power to the best oil-lamp then extant. The gas-flame showed a promptitude of action and a pliancy of adaptation unattainable with oil. By a simple automatic apparatus, the gas-flame could be made to send forth flashes in any desired succession, and of any required duration. Long and short flashes could be combined so as to render the identity of a lighthouse unmistakable, or enable it to spell its own name by the Morse alphabet. Further, Mr. Wigham had surrounded his central 'bunch' with rings of burners, to increase the light in thick weather. In a few seconds a light-keeper could pass from 28 jets to 48, and thence with equal rapidity to 68, 88, and finally to 108 jets, all these flames being under the most perfect control. The best oil-flames then known were feeble scintillations, compared with the flame of the 108-jet burner. Dr. Tyndall adds to his own the testimony of many others as to the value of the Wigham system as then examined, and proceeds to describe a later visit to the lighthouse at Galley Head, which is now, he says, without a rival in the world. In this light the refracting-lenses of four first-order apparatus are fitted one above another in the same lantern, with a 108-jet burner in the focus of each apparatus. It had already been visited by the Elder brethren of the Trinity house; and their engineer's report, he claims, was the only one unfriendly to the light. In spite of the almost unanimous opinion in its favor, the Trinity house decided in favor of a six-wick burner consuming mineral oil (Sir James Douglass's patent). Finally, Sir James, says the doctor, recognized the merits of the gas system, and decided to adopt it, but for the extinction rather than with the co-operation of Mr. Wigham.

The Trinity house replies at considerable length, giving in full the result of its investigations into the worth of the Wigham light. From these observations, the Elder brethren derived an opinion that one prominent objection to it is, that the higher powers of the single burner are obtained by increasing its size. The diameter of the 28-jet flame is four inches and a quarter; that of the 48 is five inches and seven-eighths; and so on, until a diameter of eleven inches and an eighth is reached with the 108-jet burner. Then, as the prisms of the optical apparatus are adjusted to a focus within the confines of the small flame, it follows that a great portion of the enlarged flame is extra-focal, and distributed in directions not intended by the designer of the apparatus. This effect is not particularly important in a fixed light showing all around the horizon. By far the greater number of fixed lights, however, require to be either strictly confined in angular width, or marked with color within particular bearings, which is accomplished by interposing fixed vertical screens, opaque or of colored glass, close to the glazing of the lantern. Directly the diameter of the flame is enlarged, the screen will no longer cut off the light with precision on its appointed bearings: the ex-focal rays of white light will stray into the sector which should be dark or colored, and destroy the means of guidance for which the light is intended.

The diameter of the oil-burner being constant, and its flame more compact than the Wigham burner, — for instance, the six-wick oil-burner, four inches and three-eighths wide, being equal in power to the 48-jet gas, five inches and seven-eighths wide, — it follows that oil is, according to the facts before us, more suitable for important niceties of direction. Occultation — that is, the sudden and short eclipse, at regular intervals, of an otherwise continuous light — is effectively applied with either source of illumination, but in the Wigham system is applied to flashing lights in a novel manner, as an additional means of identification. A light showing one long flash every minute, is, by occultation at short intervals, made to show a number of short flashes instead of the long one. With a widening burner, the luminous beam becomes broader, and the number of flashes seen in each series becomes greater; so that the expansion of a burner involves a change in that distinctive character upon which the observer most relies. At Galley Head this uncertainty as to the number of flashes had been observed.

These considerations led the Trinity house to the opinion that the Wigham gas system in single form could in a very few cases be employed at its higher powers without risk of perplexing the mariner; that the highest power at which its single burner could be used under every required condition was also obtainable by oil; that its special novelties in distinctiveness, as introduced at Galley Head, would only be available at widely separated stations; and that where space and considerations of expense permitted the use of gas in triform or quadriform, electricity would also be admissible, and, by its suitability for optical treatment, would be better adapted for producing the effects required in coast illumination; and, finally, its own experience with the two gas-lighted towers at Hasborough was not such as to encourage a more extended application.

The Commissioners of northern lighthouses, in answer to the letter of the Board of trade, send a report from Messrs. Thomas Stevenson and J. A. Crichton, which, in the main, agrees with that of the Trinity house.

From the paper read by Sir James Douglass before the British association in Montreal may be gleaned a few facts as to the relative powers of the best lights now in use, which are not mentioned in the correspondence just described. He states that the first electric light used in an English lighthouse in 1858 was of 700-candle power, whereas an intensity of 50,000-candle units is now found to be practically and reliably available for the focus of an optical apparatus; so that, with regard to intensity, this luminary outstrips all competitors. Compact flames are now being produced from oils and coal-gas, having an intensity of 1,500 to 2,000 candles; while, with the 108-jet Wigham burner, an intensity of nearly 3,000 candles has been reached. With regard to economy, mineral oil has the advantage of all its rivals up to the maximum intensity at which an oil light is practicable, and has the further advantage over electricity or gas in its ready application at any station, however isolated, and in many cases where the use of the other illuminants would be impracticable. He proceeds to show that fixed lights are no longer to be considered trustworthy coast-signals, owing to their liability to confusion with other lights, and that the period of a light should not exceed half a minute; further, that time should not form an element in the determination of the distinctive character of a light. On the coast of England the Trinity house is converting all fixed lights to occulting, where local dangers are required to be covered with red sectors, or sectors of danger-light. For this the electric light is eminently adapted. In cases where this local mapping-out of dangers is not required, flashing lights, in consequence of their higher intensity, are being adopted.

Referring to the optical apparatus of the new Eddystone lighthouse, he describes it as consisting of two superposed tiers of lenses with a six-wick Douglass oil-burner in the focus of each. In this respect a part of Mr. Wigham's system has assuredly been copied. With a clear atmosphere, the lower burner only is worked at its minimum intensity of about 400-candle units, giving an intensity of the flashes of the optical apparatus of about 37,000 candles; but in thick weather the full power of the two burners is put in action, with an aggregate intensity in the flashes of the optical apparatus of about 159,000-candle units. This intensity is about 23 times greater than that of the fixed light latterly exhibited from the old tower, and about 2,380 times the intensity of the light originally exhibited in the same tower, at about the same cost, from tallow candles.

THE ESSEX DENEHOLES.

THE word 'denehole' means '*den*hole,' and is pronounced '*dane*hole.' Those of Kent and South Essex may be described as consisting of narrow vertical shafts leading to artificial chambers excavated in the chalk, their depth varying with the distance of the chalk beneath the surface. They are found singly, in groups of twos and threes, or in larger collections of perhaps fifty or sixty pits.

Our illustrations show two types of the varieties of form exhibited by deneholes. The beehive shape is especially common in the shallower pits, which are wholly, or almost wholly, in chalk. A drawing of a pair of such pits discovered in a chalk cliff at Crayford brickfields is given (fig. 1). Their depth was

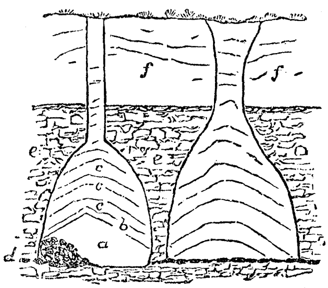

FIG. 1.

thirty-seven feet, and the greatest width eighteen feet. The walls showed no signs of metal picks, and the chalk blocks must have been prized out, but they were well and symmetrically worked. In one was a layer of very hard clay, washed into a cone at the bottom, and containing flint flakes, scrapers, and a 'core:' above that a layer of Roman pots and pans (a Samian dish, etc.) rested, followed by some very fragmentary and coarse potsherds and confused rubbish, apparently intended to fill the hole up to the surface of the ground. The sister-cave did not show an equal stratification of *débris*, and appeared to have fallen in at an early period.

Of the deeper deneholes existing in Hangman's Wood, one (fig. 2) is eighty feet deep. In three examples at Hangman's Wood (not figured) there were six chambers, while in two at Bexley only three chambers radiated from the shaft. A final stage in denehole evolution seems to have been the removal